CIGRE WG A3.06
Reliability of HV Equipment

Disconnectors and Earthing Switches
TB Part 3

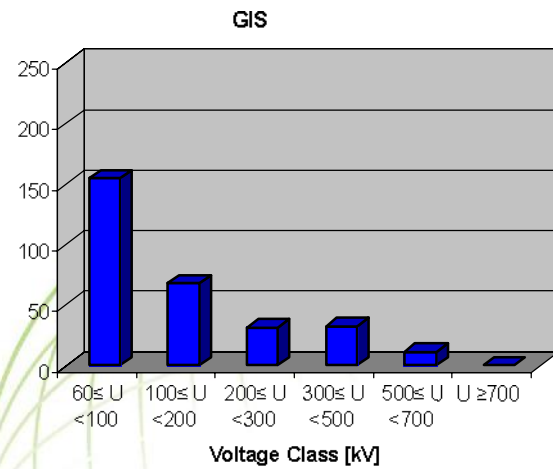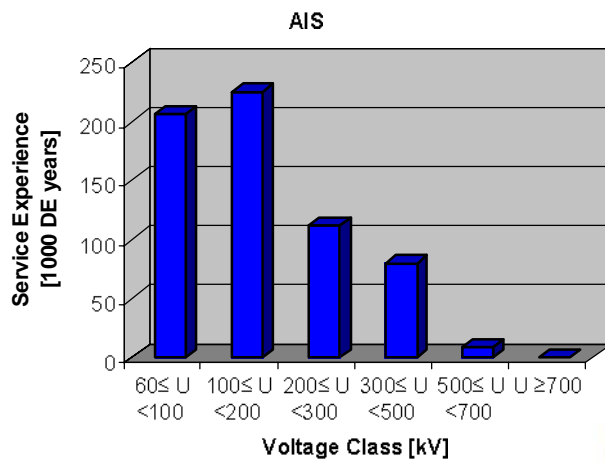Carsten Protze

Vienna 2011

1st Survey on DE

- 1st Survey on Disconnectors and Earthing Switches (DE)

- Data Collection 2004 – 2007, 25 Countries, 69 Utilities

- Service Experience [DE years]
  935 204 (68% AIS, 32% GIS)

- Number of Major Failure (MaF)
  1 959 (92% AIS, 8% GIS)

- Number of Minor Failures (MiF)
  3 001 (92% AIS, 8% GIS)

Vienna 2011

Service Experience

AIS

GIS

- AIS outdoor/indoor ratio = 19:1
- GIS outdoor/indoor ratio = 1,5:1

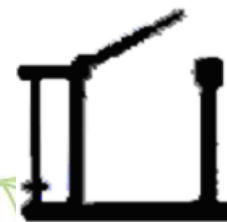**Vienna 2011**

Service Experience

- AIS disconnector design
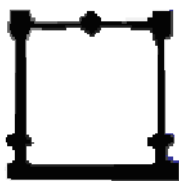
Centre break DS

Double break DS

Vertical break DS

Pantograph DS

Semi-pantograph DS

Knee type DS
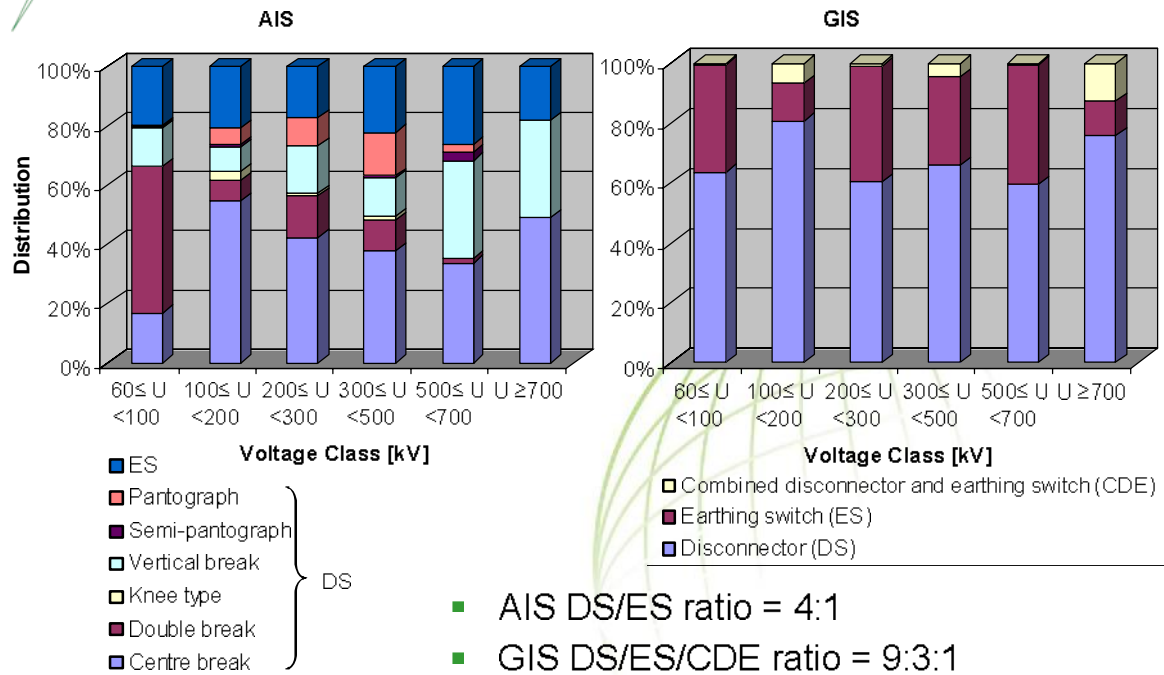
Vienna 2011

Service Experience

AIS

GIS

Distribution

Voltage Class [kV]

Voltage Class [kV]

- ES
- Pantograph
- Semi-pantograph
- Vertical break   DS
- Knee type
- Double break
- Centre break

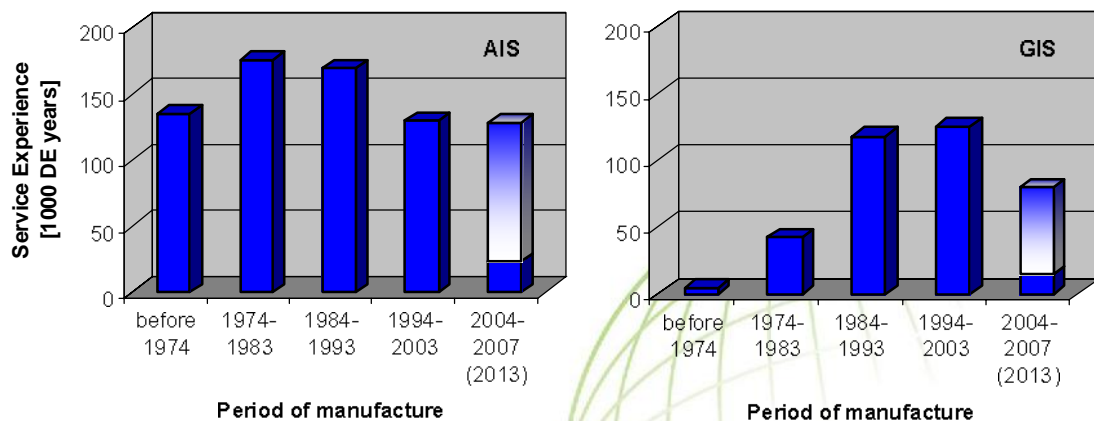- Combined disconnector and earthing switch (CDE)
- Earthing switch (ES)
- Disconnector (DS)

- AIS DS/ES ratio = 4:1
- GIS DS/ES/CDE ratio = 9:3:1
  GIS DS/ES ratio = 2,4:1 with 1 CDE = 1 DS + 1 ES

Vienna 2011

Service Experience

AIS

GIS

- 2004 - 2013 = extrapolation from 2004 - 2007

Vienna 2011

Type of operating mechanism and tendency
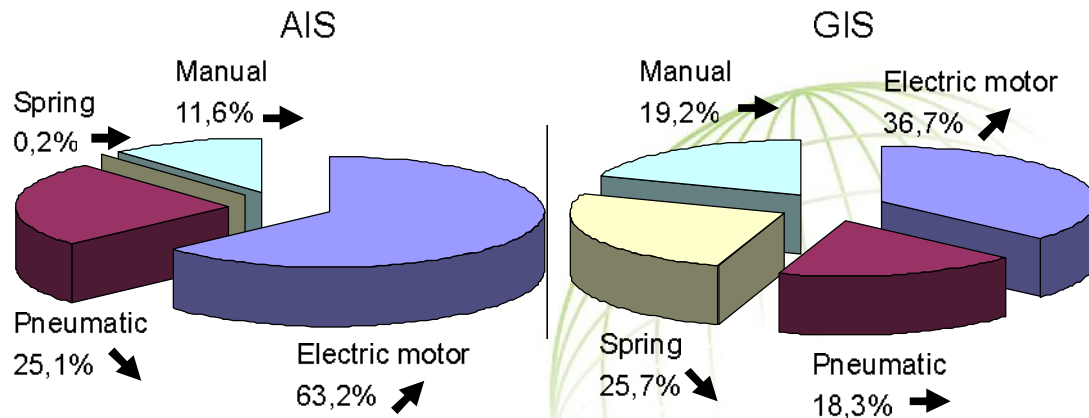
AIS

Spring 0,2%
Manual 11,6%
Pneumatic 25,1%
Electric motor 63,2%

GIS

Manual 19,2%
Electric motor 36,7%
Spring 25,7%
Pneumatic 18,3%

Major Failure Frequency - AIS

MaF frequency [failures per 100 DE years]

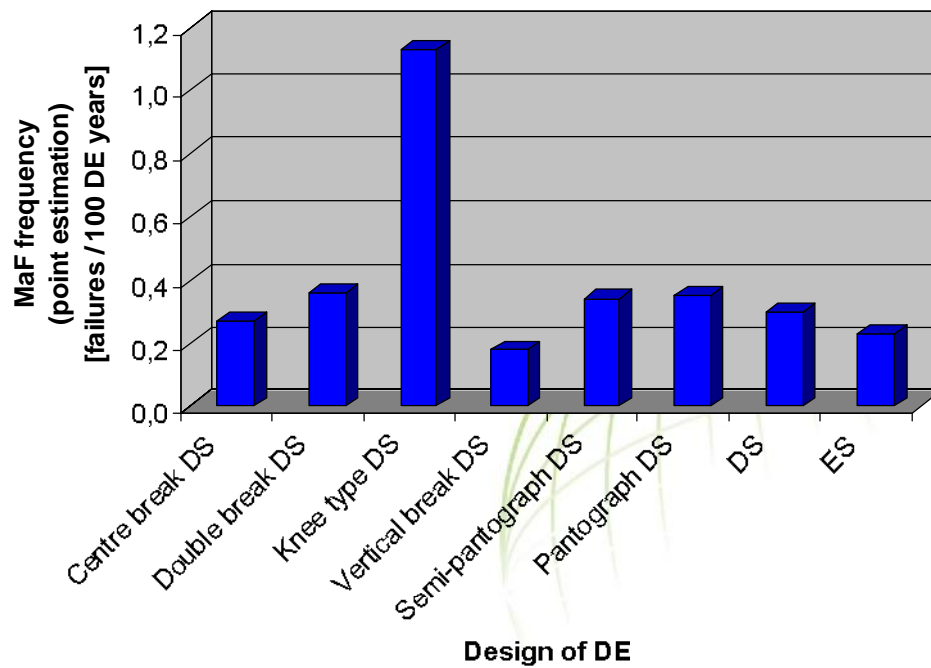upper limit — point estimation — lower limit

Voltage class [kV]
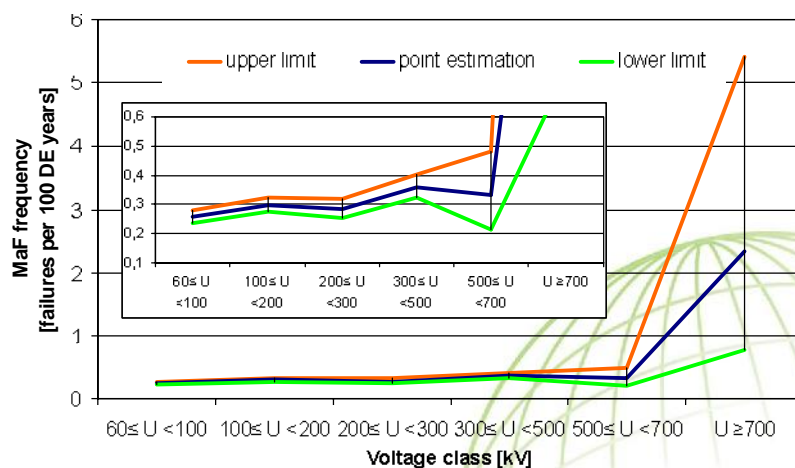
- MaF frequency (AIS DE) = 0,29 failures / 100 DE years
- MaF frequency (DS) = 1,3 · MaF frequency (ES)
- MaF frequency (outdoor) = 2,3 · MaF frequency (indoor)

Major Failure Frequency - AIS

Vienna 2011

Major Failure Frequency - AIS

Vienna 2011

Major Failure Frequency - AIS

Vienna 2011

Major Failure Frequency - AIS

- Drive responsible for 69% MaF

Vienna 2011

Major Failure Frequency - AIS
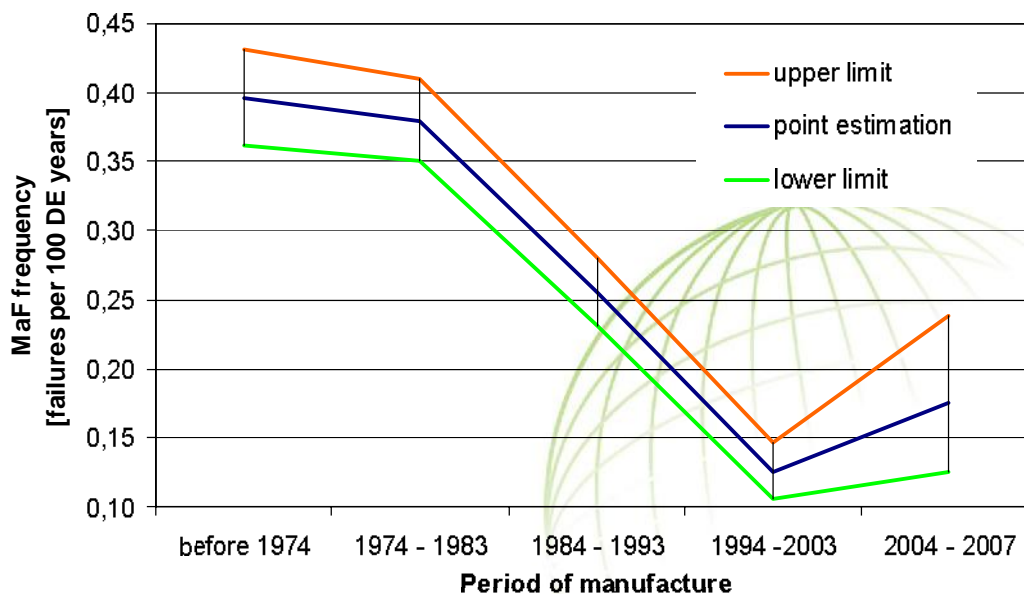
Failure Characteristic - AIS

- Responsible component for failure
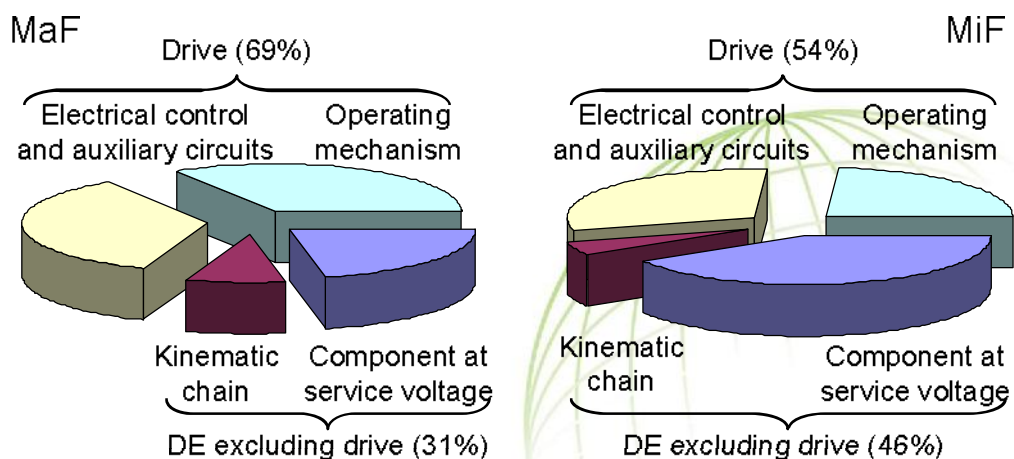
Failure Characteristic / Maintenance - AIS

- Main MaF mode: Does not operate on command (72%)

- Main primary failure cause: Wear, Aging (MaF 60% / MiF 68%)

- Main repair type of failure: On site (MaF 89% / MiF 84%)
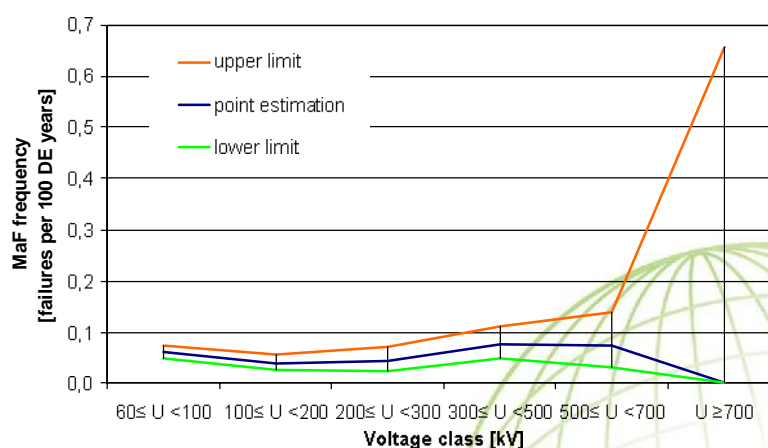
- Maintenance philosophy
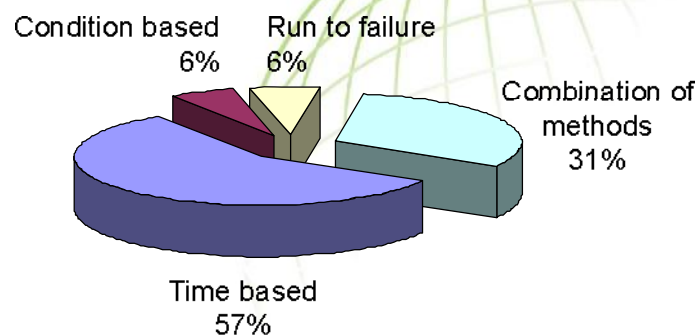
Condition based 6%
Run to failure 6%
Combination of methods 31%
Time based 57%

Vienna 2011

Major Failure Frequency - GIS

- MaF frequency (GIS DE)   = 0,054 failures / 100 DE years

- MaF frequency (DS)   = 1,3 · MaF frequency (ES)
                                           = 0,6 · MaF frequency (CDE)
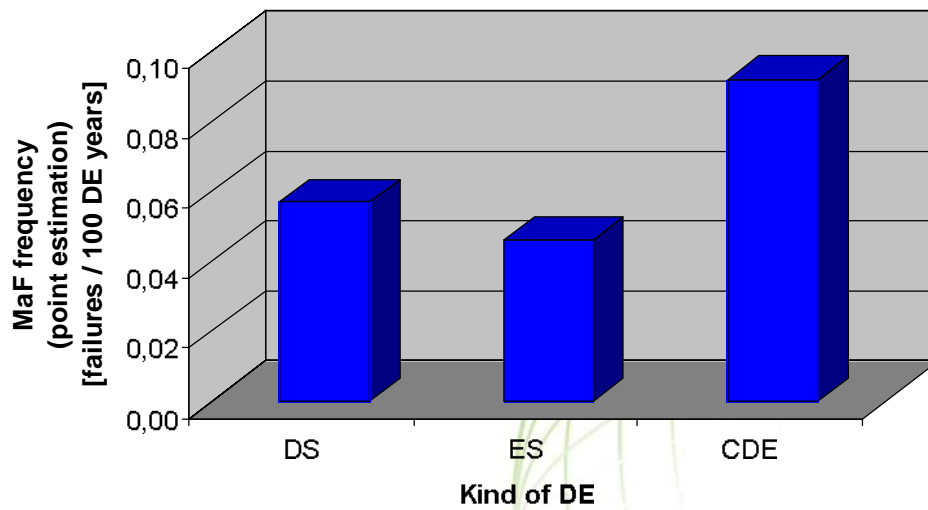
- MaF frequency (outdoor)   = 2,3 · MaF frequency (indoor)

Vienna 2011
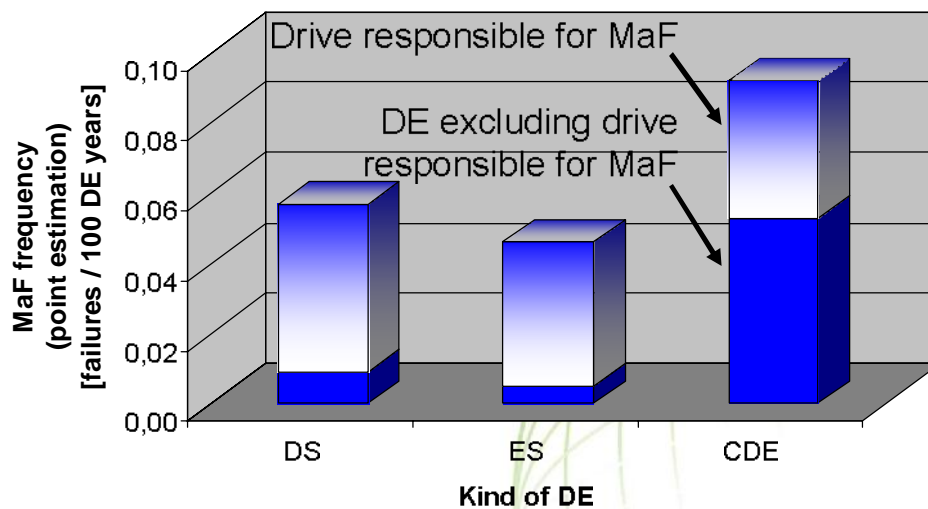
Major Failure Frequency - GIS

Vienna 2011

Major Failure Frequency - GIS

Vienna 2011

Major Failure Frequency - GIS

Vienna 2011

Major Failure Frequency - GIS
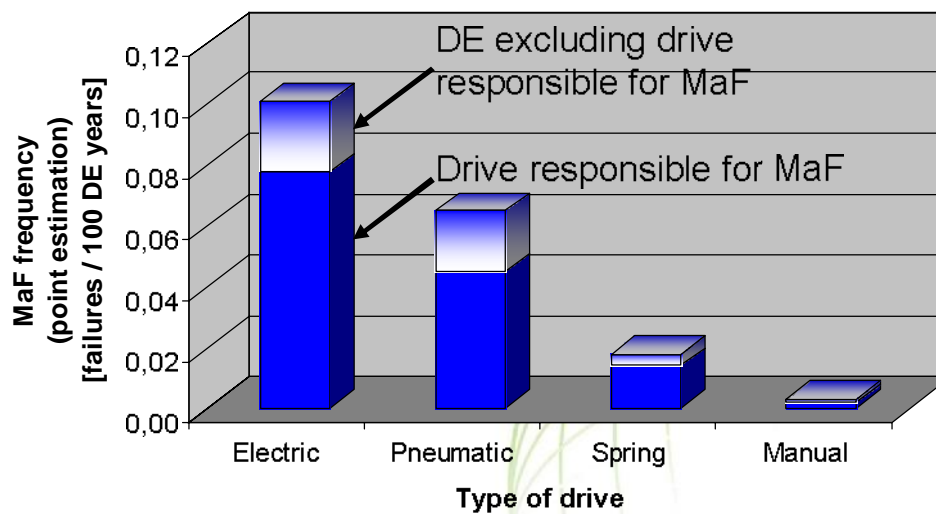
- Drive responsible for 81% MaF

Vienna 2011

Major Failure Frequency - GIS
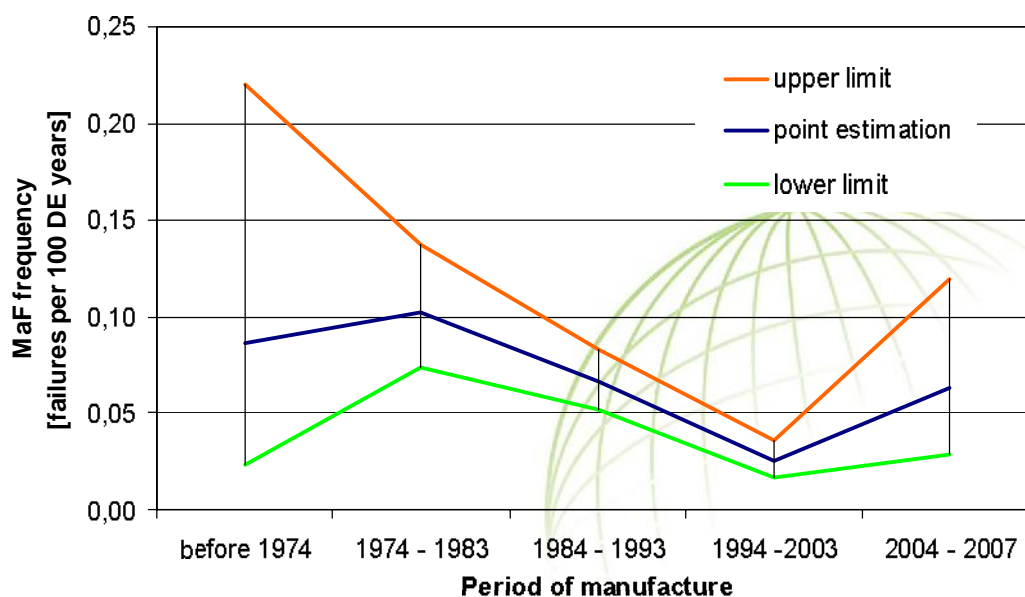
Failure Characteristic - GIS

- Responsible component for failure
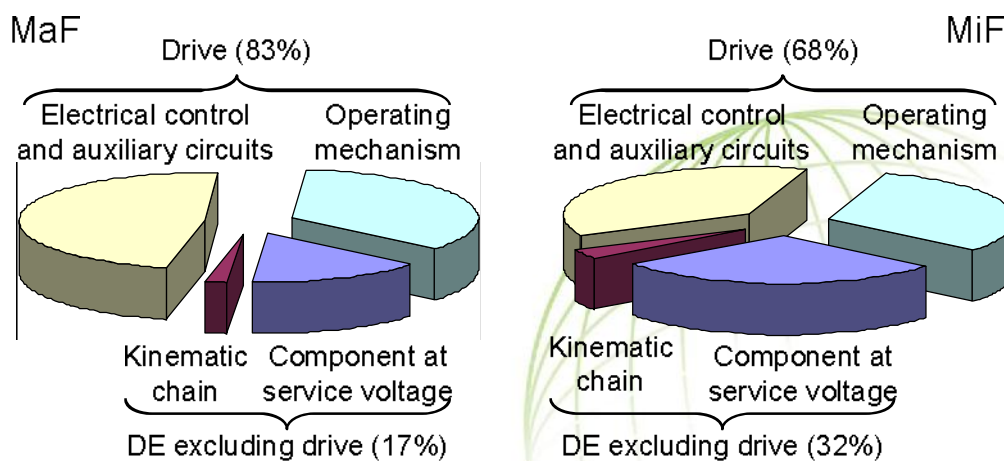
Failure Characteristic - GIS

- Main MaF mode: Does not operate on command (79%)

- Main MiF mode: Small SF_6 leakage (31%)

- Main primary failure cause: Wear, Aging (MaF 66% / MiF 63%)

Vienna 2011

Main Conclusions

- MaF frequency (AIS) > MaF frequency (GIS)

- MaF frequency (DS) > MaF frequency (ES)

- MaF frequency (outdoor) > MaF frequency (indoor)

- MaF frequency (upper voltage) > MaF frequency (lower voltage)

- MaF frequency (older DE) > MaF frequency (younger DE)

- App. 70% of MaF caused by drive (except for manual drive)
  ➡ Call for improvement

- Main failure causes (MaF, MiF): Wear and aging

Vienna 2011

Thank you for your kind attention!

Vienna 2011